Claims

1. (Currently Amended) A computer-readable medium having computer-readable instructions embedded therein which, when executed by a computer, cause the computer to implement a method for facilitating determination of equilibrium values for a market system, the method for facilitating determination of equilibrium values for the market system comprising:

receiving a number of types of goods m, a number of buyers $(n + 1)$, an initial amount of each good that each buyer possesses, and a utility function for each of buyers $i=1,\ldots,n$, for the market system;

~~receiving supply and demand data for a market system;~~

~~demarcating at least a subset of the data into buyer data and seller data;~~

applying a polynomial-time approximation method to the ~~demarcated~~ received data to generate an approximate equilibrium price vector for the market system, the polynomial-time approximation method ~~comprises~~ comprising:

initializing with an arbitrary first price vector p;

setting a variable, D, to represent a maximum deficiency [[of]] for the first price vector p;

constructing an instance, M_p, of ~~a dichotomous~~ the market system, wherein constructing the instance, M_p, of the market system comprises:

providing m types of goods and $(n + 1)$ buyers;

setting, for $i = 1,\ldots,n$, a utility of buyer i for the goods as to be calculated from the corresponding utility function;

establishing the budget of buyers $i = 1,\ldots,n$, according to:

$$e_i := \sum_{j=1}^{m} p_j w_j^i$$

wherein e_i is the budget of buyer i, p_j is the price of good j in the first price vector, and w_j^i is equal to an initial amount of good j that buyer i possesses;

setting, for $i = (n + 1)$, a utility of buyer i for each of goods $i = 1, \ldots, m$, as equal to p_j; and

establishing the budget of buyer $i = (n + 1)$ as $e_{(n+1)} := D$;

executing a DPSV algorithm on the instance, M_p, starting from the first price vector p and increasing prices until equilibrium is reached, and outputting a second price vector (p') via execution of the DPSV algorithm;

setting a budget e_i' [[for i]] for ~~every agent~~ each buyer i with respect to the second price vector (p') according to:

$$e_i' := \sum_{j-1}^{m} p_j' w_j^i;$$

determining if a budget ratio (ei'/ei) for ~~every agent~~ each buyer i satisfies a budget ratio constraint of:

$$\frac{e_i'}{e_i} \leq 1 + \varepsilon,$$

wherein ε represents a desired amount of approximation;

~~outputting~~ identifying the second price vector (p') when the budget ratio constraint is satisfied for every buyer i [[,]] as the approximate equilibrium price vector for the market system; and

iterating the polynomial-time approximation method with the first price vector p set equal to the second price vector (p'), instead of an arbitrary

price vector, when the budget ratio constraint is unsatisfied, until the budget ratio constraint is satisfied;

~~sending results from the polynomial time approximation method to an iterative analysis controller component to determine if the results meet a predetermined threshold error value to halt an equilibrium modeling component; and~~

outputting the approximate equilibrium price vector ~~data~~ to a computer monitor display; and

setting prices based on the approximate equilibrium price vector.

2. (Canceled)

3. (Currently Amended) The computer-readable medium of claim 1, wherein the approximate equilibrium price vector[[,]] ~~comprising~~ comprises an approximate equilibrium price vector, *p**, that produces, in conjunction with a bundle of goods[[, x^i,]] for each ~~agent~~ buyer *i*, an ε -approximate equilibrium for the market system such that:

for every good *j*:

$$(1-\varepsilon)\ \sum_{i=1}^{n} w_j^i \leq \sum_{i=1}^{n} x_j^i \leq \sum_{i=1}^{n} w_j^i;$$

wherein x_j^i is the number of good *j* in the bundle of goods of buyer *i*;

and for all *i*, a utility, $\sum_{j=1}^{m} u_{ij} x_j^i$ of ~~agent~~ buyer *i* is ~~at least~~ equal to or greater than (1- ε) times a value of an optimum solution of a maximization of the utility function[[, $u_i(x)$,]] for the buyer *i* subject to:

$$[[\sum_{j=1}^{m} p_j^* x_j \leq \sum_{j=1}^{m} p_j^* w_j^i;]]\ \cancel{(\text{Eq. 1})}$$

$$\sum_{j=1}^{m} p_j^* x_j^i \leq \sum_{j=1}^{m} p_j^* w_j^i;$$

wherein m represents ~~types of divisible goods being traded in the market system~~ the number of types of goods and w_j^i indicates [[an]] the initial amount of good j that ~~agent~~ buyer i possesses.

4. (Currently Amended) The computer-readable medium of claim 1, wherein the polynomial-time approximation method ~~comprising~~ comprises an iterative method that utilizes, at least in part, revenue generated in a previous iteration for a specific ~~agent~~ buyer as a budget for the specific ~~agent~~ buyer in a current iteration.

5. (Currently Amended) The computer-readable medium of claim 4, wherein the iterative method further ~~utilizing~~ utilizes a dummy buyer to account for residual goods.

6. (Currently Amended) The computer-readable medium of claim 1, wherein the polynomial-time approximation method ~~comprising~~ comprises, at least in part, a linear utility function ~~relating to~~ for at least one ~~agent~~ buyer.

7. (Canceled)

8. (Canceled)

9. (Canceled)

10. (Canceled)

11. (Currently Amended) The computer-readable medium of claim 1, wherein the polynomial-time approximation method ~~yielding~~ yields an exact equilibrium price for the market system.

12. (Currently Amended) A computer-implemented method for facilitating determination of equilibrium values for a market system, comprising:

receiving, by a computing system, a number of types of goods m, a number of buyers $(n + 1)$, an initial amount of each good that each buyer possesses, and a utility function for each of buyers $i = 1,...,n$, for the market system;

~~receiving supply and demand data for a market system via a computer processor;~~

~~demarcating at least a subset of the data into buyer data and seller data;~~

applying, by the computing system, a polynomial-time approximation method to the ~~demarcated~~ received data to generate an approximate equilibrium price vector for the market system, the polynomial-time approximation method ~~comprises~~ comprising:

initializing with an arbitrary first price vector p;

setting a variable, D, to represent a maximum deficiency [[of]] for the first price vector p;

constructing an instance, M_p, of [[a]] the ~~dichotomous~~ market system, wherein constructing the instance, M_p, of the market system comprises:

providing m types of goods and $(n + 1)$ buyers;

setting, for $i = 1,\ldots,n$, a utility of buyer i for the goods as to be calculated from the corresponding utility function;

establishing the budget of buyers $i = 1,\ldots,n$, according to:

$$e_i := \sum_{j=1}^{m} p_j w_j^i,$$

wherein e_i is the budget of buyer i, p_j is the price of good j in the first price vector, and w_j^i is equal to an initial amount of good j that buyer i possesses;

setting, for $i = (n + 1)$, a utility of buyer i for each of goods $j = 1,\ldots,m$, as equal to p_j; and

establishing the budget of buyer $i = (n + 1)$ as $e_{(n+1)} := D$;

executing a DPSV algorithm on the instance, M_p, starting from the first price vector p and increasing prices until equilibrium is reached, and outputting a second price vector (p');

setting a budget e_i' [[for i]] for ~~every agent~~ each buyer i with respect to the second price vector (p') according to:

$$e_i' := \sum_{j=1}^{m} p_j' w_j^i;$$

determining if a budget ratio (e_i'/e_i) for ~~every agent~~ each buyer i satisfies a budget ratio constraint of:

$$\frac{e_i'}{e_i} \leq 1 + \varepsilon,$$

wherein ε represents a desired amount of approximation;

~~outputting~~ identifying the second price vector *(p')* when the budget ratio constraint is satisfied for every buyer *i* [[,]] as the approximate equilibrium price vector for the market system; and

iterating the polynomial-time approximation method with the first price vector *p* set equal to the second price vector *(p')*, instead of an arbitrary price vector, when the budget ratio constraint is unsatisfied, until the budget ratio constraint is satisfied;

~~sending results from the polynomial time approximation method to an iterative analysis controller component to determine if the results meet a predetermined threshold error value to halt an equilibrium modeling component; and~~

outputting the approximate equilibrium price vector ~~data~~ to a computer monitor display; and

setting prices based on the approximate equilibrium price vector.

13. (Canceled)

14. (Currently Amended) The computer-implemented method for facilitating determination of equilibrium values for the market system of claim 12, wherein the approximate equilibrium price vector [[,]] ~~comprising~~ comprises an approximate equilibrium price vector, p^*, that produces, in conjunction with a bundle of goods [[,x^i,]] for each ~~agent~~ buyer *i*, an ε-approximate equilibrium for the market system such that:

for every good j:

$$(1-\varepsilon)\quad \sum_{i=1}^{n} w_j^i \quad \le \sum_{i=1}^{n} x_j^i \le \sum_{i=1}^{n} w_j^i;$$

wherein x_j^i is the number of good *j* in the bundle of goods of buyer *i;* and for all *i*, a utility, $\sum_{j-1}^{m} u_{ij} x_j^i$, of ~~agent~~ buyer *i* is ~~at least~~ equal to or greater than (1-ε) times a value of an optimum solution of a maximization of the utility function [[$u_i(x)$,]] for the buyer *i* subject to:

[[$\sum_{j=1}^{m} p_j^* x_j \le \sum_{j=1}^{m} p_j^* w_j^i$;]] ~~(Eq. 1)~~

$$\sum_{j=1}^{m} p_j^* x_j^i \quad \le \sum_{j=1}^{m} p_j^* w_j^i;$$

wherein *m* represents ~~types of divisible goods being traded in the market system~~ the number of types of goods and w_j^i indicates [[an]] the initial amount of good *j* that ~~agent~~ buyer *i* possesses.

15. (Currently Amended) The computer-implemented method for facilitating determination of equilibrium values for the market system of claim 12, wherein the polynomial-time approximation method ~~comprising~~ comprises an iterative method that utilizes, at least in part, revenue generated in a previous iteration for a specific ~~agent~~ buyer as a budget for the specific ~~agent~~ buyer in a current iteration.

16. (Currently Amended) The computer-implemented method for facilitating determination of equilibrium values for the market system of claim 15, wherein the iterative method further ~~utilizing~~ utilizes a dummy buyer to account for residual goods.

17. (Canceled)

18. (Canceled)

19. (Canceled)

20. (Currently Amended) The computer-implemented method for facilitating determination of equilibrium values for the market system of claim 12, wherein the polynomial-time approximation method ~~yielding~~ yields an exact equilibrium price for the market system.

21. (Canceled)

22. (Canceled)

23. (Currently Amended) A computer system that facilitates determination of equilibrium values for a market system, comprising:

a processor; and

a memory connected to the processor;

wherein the processor and the memory perform the steps of:

receiving a number of types of goods m, a number of buyers $(n + 1)$, an initial amount of each good that each buyer possesses, and a utility function for each of buyers $i = 1,...,n$, for the market system;

~~means for receiving supply and demand data for a market system, and demarcating at least a subset of the data into buyer data and seller data;~~

~~means for~~ applying a polynomial-time approximation method to the ~~demarcated~~ received data to generate an approximate[[d]] equilibrium price vector for the market system, the polynomial-time approximation method ~~comprises~~ comprising:

initializing with an arbitrary first price vector p;

setting a variable, D, to represent a maximum deficiency [[of]] for the first price vector p;

constructing an instance, M_p, of [[a]] the ~~dichotomous~~ market system, wherein constructing the instance, M_p of the market system comprises:

providing m types of goods and $(n + 1)$ buyers;

setting, for $i = 1,\ldots,n$, a utility of buyer i for the goods as to be calculated from the corresponding utility function;

establishing the budget of buyers $i = 1,\ldots,n$, according to:

$$e_i := \sum_{j=1}^{m} p_j w_j^i,$$

wherein e_i is the budget of buyer i, p_j is the price of good j in the first price vector, and w_j^i is equal to an initial amount of good j that buyer i possesses;

setting, for $i = (n + 1)$, a utility of buyer i for each of goods $j=1,\ldots,m$, as equal to p_j; and

establishing the budget of buyer $i = (n + 1)$ as $e_{(n+1)} := D$;

executing a DPSV algorithm on the instance, M_p, starting from the first price vector p and increasing prices until equilibrium is reached, and outputting a second price vector (p');

setting a budget $\underline{e_i'}$[[for *i*]] for ~~every agent~~ <u>each buyer</u> *i* with respect to the second price vector <u>*(p')*</u> according to:

$$e_i' := \sum_{j=1}^{m} p_j' w_j^i;$$

determining if a budget ratio <u>*(e_i'/e_i)*</u> for ~~every agent~~ <u>each buyer</u> *i* satisfies a budget ratio constraint of:

$$\frac{e_i'}{e_i} \leq 1 + \varepsilon,$$

where<u>in</u> ε represents a desired amount of approximation;

~~outputting~~ <u>identifying</u> the second price vector <u>*(p')*</u> when the budget <u>ratio</u> constraint is satisfied <u>for every buyer</u> *i* [[,]] as the approximate equilibrium price vector for the market system; and

iterating the polynomial-time approximation method with the first price vector <u>*p*</u> set equal to the second price vector <u>*(p')*, instead of an arbitrary price vector,</u> when the budget <u>ratio</u> constraint is unsatisfied<u>, until the budget ratio constraint is satisfied</u>;

~~means for sending results from the polynomial time approximation method to an iterative analysis controller component to determine if the results meet a predetermined threshold error value to halt an equilibrium modeling component; and~~

~~means for~~ outputting <u>the</u> approximate equilibrium price vector ~~data to~~ a computer monitor display<u>; and</u>

<u>setting prices based on the approximate equilibrium price vector</u>.

24. (Canceled)

25. (Currently Amended) The computer system of claim 23, wherein the polynomial-time approximation method ~~comprising~~ comprises an iterative method that utilizes, at least in part, revenue generated in a previous iteration for a specific ~~agent~~ buyer as a budget for the specific ~~agent~~ buyer in a current iteration.

26. (Currently Amended) The computer system of claim 23, wherein the polynomial-time approximation method ~~employing, at least in part, a dichotomous market solution algorithm to provide at least one price selected from the group consisting of an approximate market equilibrium price and~~ yields an exact equilibrium ~~market~~ price for the market system.

27. (Canceled)

28. (Canceled)

29. (Canceled)

30. (Canceled)